

CLAIMS

1. A radio transmitting apparatus comprising:
 - a plurality of antennas;
 - 5 a modulated signal number setting section that sets a number of modulated signals transmitted using said plurality of antennas; and
 - a transmit power changing section that changes modulated signal transmit power according to a number
 - 10 of transmit modulated signals.
2. The radio transmitting apparatus according to claim 1, wherein: said transmit power changing section has a pilot symbol forming section; and said pilot symbol
- 15 forming section changes a signal point arrangement when a pilot symbol is formed so that a ratio of data symbol transmit power to pilot symbol transmit power changes according to a number of transmit modulated signals.
- 20 3. The radio transmitting apparatus according to claim 2, wherein said pilot symbol forming section decides a signal point arrangement of pilot symbols in accordance with combined transmit power of data symbols transmitted simultaneously.
- 25 4. The radio transmitting apparatus according to claim 2, wherein said pilot symbol forming section selects a

signal point arrangement so that pilot symbol signal point amplitude increases the greater the number of transmit modulated signals.

- 5 5. The radio transmitting apparatus according to claim 2, wherein said pilot symbol forming section decides a signal point arrangement based on a ratio of a number of simultaneously transmitted pilot symbols to a number of simultaneously transmitted data symbols.

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6. The radio transmitting apparatus according to claim 1, wherein said transmit power changing section changes transmit power of each modulated signal at timing at which a number of transmit modulated signals is switched to
15 a number set by said modulated signal number setting section.

7. The radio transmitting apparatus according to claim 6, wherein said transmit power changing section makes
20 transmit power of each modulated signal smaller when a number of transmit modulated signals increases.

8. The radio transmitting apparatus according to claim 6, wherein said transmit power changing section makes transmit power of each modulated signal larger when a
25 number of transmit modulated signals decreases.

9. The radio transmitting apparatus according to claim

6, wherein said transmit power changing section gradually restores changed transmit power of each modulated signal to a value prior to switching of a number of modulated signals.

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10. A radio transmission method whereby different modulated signals are transmitted simultaneously from a plurality of antennas and a number of simultaneously transmitted modulated signals is varied; wherein
10 modulated signal transmit power is changed according to a number of modulated signals transmitted simultaneously.

11. The radio transmission method according to claim 10, wherein pilot symbol transmit power is changed so that
15 composite signal power of pilot symbols transmitted simultaneously becomes equal to composite signal power of data symbols transmitted simultaneously.

12. The radio transmission method according to claim 10,
20 wherein transmit power of each modulated signal is changed at timing at which a number of transmit modulated signals is switched.

ABSTRACT

A radio transmitting apparatus that has a plurality of antennas and changes the number of modulated signals transmitted simultaneously according to the propagation environment and so forth. A transmission power changing section 12 of a radio transmitting apparatus of the present invention adjusts the pilot symbol signal level so as to match the data symbol composite signal level according to the number of transmit modulated signals set by a modulated signal number setting section 11. By this means, the operating range of received pilot symbols and the operating range of received data symbols become approximately the same on the receiving side, enabling pilot symbol quantization error to be reduced. As a result, the precision of radio wave propagation environment estimation, time synchronization, and frequency offset estimation using pilot symbols improves, and consequently data reception quality improves.

[FIG.1]

MODULATED SIGNAL A

MODULATED SIGNAL B

5

[FIG.2]

MODULATED SIGNAL A

MODULATED SIGNAL B

TIME

10

[FIG.3]

10 RADIO TRANSMITTING APPARATUS

11 MODULATED SIGNAL NUMBER SETTING SECTION

12 TRANSMIT POWER CHANGING SECTION

15 MODULATED SIGNAL 1

MODULATED SIGNAL 2

MODULATED SIGNAL n

[FIG.4]

20 MODULATED SIGNAL A

MODULATED SIGNALB

[FIG.5A]

MODULATED SIGNAL A

25 FREQUENCY

TIME

CARRIER 1

...

[FIG.5B]

MODULATED SIGNAL B

FREQUENCY

5 TIME

CARRIER 1

...

101: SIGNAL DETECTION SYMBOL

102: CONTROL SYMBOL

10 103: TRANSMISSION METHOD INFORMATION SYMBOL

104: RADIO WAVE PROPAGATION ENVIRONMENT ESTIMATION SYMBOL

105: DATA SYMBOL

PILOT SYMBOLS

15 [FIG.7A]

MODULATED SIGNAL A

TIME

CARRIER 1 ...

20 [FIG.8]

MODULATED SIGNAL A

MODULATED SIGNAL B

MODULATED SIGNAL C

MODULATED SIGNAL D

25

[FIG.12A]

MODULATED SIGNAL A

TIME
 MODULATED SIGNAL B
 TIME

 5 [FIG.12B]
 COMPOSITE SIGNAL
 TIME

 [FIG.12C]
 10 PILOT SIGNAL
 TIME

 [FIG.12D]
 PILOT SIGNAL
 15 TIME

 [FIG.14]
 500 RADIO TRANSMITTING APPARATUS
 501 DATA SEQUENCE GENERATION SECTION
 20 502A MODULATION SECTION
 ...
 505A RADIO SECTION
 ...
 S10 TRANSMISSION METHOD REQUEST INFORMATION
 25 S11 MODULATION METHOD REQUEST INFORMATION
 507 FRAME CONFIGURATION SIGNAL GENERATION SECTION

[FIG.15]

502A (502B-502D) MODULATION SECTION
510 DATA SYMBOL MAPPING SECTION
511 TRANSMISSION METHOD INFORMATION SYMBOL MAPPING
5 SECTION
512 PILOT SYMBOL MAPPING SECTION
513 SIGNAL SELECTION SECTION

[FIG.16]

10 512 PILOT SYMBOL MAPPING SECTION
520 TWO-TRANSMITTING-ANTENNA PILOT SYMBOL GENERATION
SECTION
521 FOUR-TRANSMITTING-ANTENNA PILOT SYMBOL GENERATION
SECTION
15 522 SIGNAL SELECTION SECTION

[FIG.17]

600 RADIO RECEIVING APPARATUS
601A RADIO SECTION
20 ...
603A MODULATED SIGNAL A, B, C, AND D CHANNEL ESTIMATION
SECTION
...
604 DEMODULATION, FREQUENCY OFFSET ESTIMATION, AND
25 TRANSMISSION METHOD DETECTION SECTION
605 TRANSMISSION METHOD AND MODULATION METHOD
DETERMINATION SECTION

REQUEST INFORMATION

606 SIGNAL DETECTION AND SYNCHRONIZATION SECTION

[FIG.18]

5 601A (601B-601D) RADIO SECTION

610 GAIN CONTROL SECTION

611 QUADRATURE DEMODULATION SECTION

612 ANALOG/DIGITAL CONVERSION SECTION

613 ANALOG/DIGITAL CONVERSION SECTION

10

[FIG.19]

TWO TRANSMITTING ANTENNAS

SWITCHING OF NUMBER OF TRANSMITTING ANTENNAS

15 FOUR TRANSMITTING ANTENNAS

TIME

[FIG.20]

FOUR TRANSMITTING ANTENNAS

20 SWITCHING OF NUMBER OF TRANSMITTING ANTENNAS

TWO TRANSMITTING ANTENNAS

TIME

[FIG.25]

25 SWITCHING OF NUMBER OF TRANSMITTING ANTENNAS

TWO TRANSMITTING ANTENNAS

FOUR TRANSMITTING ANTENNAS

TRANSMITTING ANTENNA T1
TRANSMITTING ANTENNA T2
TRANSMITTING ANTENNA T3
TRANSMITTING ANTENNA T4

5 TIME

[FIG.26]

SWITCHING OF NUMBER OF TRANSMITTING ANTENNAS
FOUR TRANSMITTING ANTENNAS

10 TWO TRANSMITTING ANTENNAS

TRANSMITTING ANTENNA T1
TRANSMITTING ANTENNA T2
TRANSMITTING ANTENNA T3
TRANSMITTING ANTENNA T4

15 TIME

[FIG.27A]

POWER

FREQUENCY

20

[FIG.28]

700 RADIO TRANSMITTING APPARATUS

501 DATA SEQUENCE GENERATION SECTION

502A MODULATION SECTION

25 ...

505A RADIO SECTION

...

701A GAIN CONTROL SECTION

...

S10 TRANSMISSION METHOD REQUEST INFORMATION

S11 MODULATION METHOD REQUEST INFORMATION

5 507 FRAME CONFIGURATION SIGNAL GENERATION SECTION

[FIG.29A]

MODULATED SIGNAL A

FREQUENCY

10 TIME

CARRIER 1

...

[FIG.29D]

15 MODULATED SIGNAL D

FREQUENCY

TIME

CARRIER 1

...

20 2701: SIGNAL DETECTION SYMBOL

2702: GAIN CONTROL SYMBOL

2703: FREQUENCY OFFSET ESTIMATION SYMBOL

2704: TRANSMISSION METHOD INFORMATION SYMBOL

2705: RADIO WAVE PROPAGATION ENVIRONMENT ESTIMATION

25 SYMBOL

2706: DATA SYMBOL

PILOT SYMBOLS

[FIG.30]

MODULATED SIGNAL A

MODULATED SIGNAL B

5 MODULATED SIGNAL C

MODULATED SIGNAL D

COMPOSITE SIGNAL

TIME

2701: SIGNAL DETECTION SYMBOL

10 2702: GAIN CONTROL SYMBOL

2703: FREQUENCY OFFSET ESTIMATION SYMBOL

2704: TRANSMISSION METHOD INFORMATION SYMBOL

2705: RADIO WAVE PROPAGATION ENVIRONMENT ESTIMATION
SYMBOL

15 2706: DATA SYMBOL

[FIG.32]

SIGNAL POINT ARRANGEMENT IN SUBCARRIER k ($k = 1, \dots, N$)

20 MODULATED SIGNAL A

MODULATED SIGNAL B

SIGNALS COMBINED IN SUBCARRIER k ($k = 1, \dots, N$)

[FIG.34]

25 MODULATED SIGNAL A

MODULATED SIGNAL B

MODULATED SIGNAL C

SIGNALS COMBINED IN SUBCARRIER k ($k = 1, \dots, N$)

5 SIGNAL POINT ARRANGEMENT IN SUBCARRIER k ($k = 1, \dots, N$)

MODULATED SIGNAL B

10

MODULATED SIGNAL A 64{ }16

MODULATED SIGNAL B } 16

MODULATED SIGNAL C } 16

15 MODULATED SIGNAL D } 16

TIME

TOTAL OF 64

TOTAL OF 64